

Managing cooling comfort at homes and offices: An austerity measures

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ABSTRACT

People today experience coolness through the use technology (air conditioners) that produces cooling comfort at homes, at offices and even in cars and buses. More importantly, a simple homeowner needs to select an air conditioner that matches the size of a room to install it in, in order to make full use of its capacity or choose to pay more without following the intention of learning the basics of care and maintenance of the unit. The study is then conducted to assess setting up the cooling capacity needed for a particular room size, where to place the unit and what must be done in order to maintain the unit in good operating condition. The study gathers such idea from the office personnel, homeowners (includes lodgers, bed spacers, and transients) taken purposively at random (non-probability sampling procedure using quota). Customarily, people experiencing cooling comfort has the inner motive to work productively and efficiently. The study finds that for most homeowners learned the cooling capacity of a space through a friend and placing it on window line upper part is the common sight for most window type package air conditioners with at most five (5) occupants. The office personnel, on the other hand, stated that the units were provided by the owner of the building when moving in seeing it mounted on floors, walls or ceiling. The prevailing conditions on people's awareness on the practices are limited to what was usually heard from the store attendant upon buying the air conditioners. Information contained on the sheet provided upon receipt of the unit were left unscanned and unattended to. These practices form the basis for recommendations leading to the attainment of experiencing cooling comfort at lower cost.

Keywords: air conditioning, cooling capacity, do – it – by yourself, thermostat

I. INTRODUCTION

The Philippines as a tropical country is hot and humid with an average yearly temperature of 26.6°C (PAGASA – DOST). Depending on the location and season (hot, rainy and cool dry), one has to be comfortable in the place whether in work or at home and be productive and efficient as can be (Frontczak & Wargocki, 2011). Being comfortable is feeling the coolness of the air that refreshes oneself on either hot or cool dry days. The air in this state is maintained to a temperature between 22°C to 25°C and is known to be the best temperature for the human body. However, this temperature can be adjusted 2°C higher during sleep (Hutchison, 2009).

This coolness is produced either naturally (evaporative cooling) through the breeze of a wind that blows the water vapor in the air or industrially through the air maintained to desired coolness dispelled by the fan motor of the air conditioning unit installed. Understanding the concept allows every person to move comfortably - the very reason of the growth of the technology in air conditioning as installed in residential houses, commercial buildings, even establishments such as malls, hospitals and the transportation industry (industrial applications).

The role of air-conditioning invades even the rural areas and that Filipinos from all sectors of the society love to stay in an air-conditioned space rather than on

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the shade beneath the tree even during sleep. Whether one uses the original system or the green technology that maintain an eco-friendly environment and at the same time save the power consumption (Boafo, 2014), such comfort enjoyed has cost.

Having an air conditioner installed at homes or offices comes with a cost; the cost of installation, maintenance, power, and even the mismatched cooling capacity to the area being cooled (Saito, 2006). These result to bills piled on the rack, unlike the times when people enjoyed the natural cooling, feeling the breeze that nature provides – it is free (Brager & Dear, 1998). For most common people, the practice is to buy the unit as seen on media broadcast commercials else on people who promote such product; installed at a place of choice not even knowing why the manufacturer suggests such location; call maintenance personnel whenever cooling is no longer efficient even if only the louvers and filters need cleaning and pays the maintenance and electric bill at the end of the month (Atkinson, 2013). Not knowing these basic information increases the cost of maintenance and electricity.

The study then aims to provide awareness on what unit to install; where to place or install the unit at homes; matched the capacity of the unit to the space to be cooled and do – it – yourself practices in maintaining the units. These help non-technical people save electricity and maintenance cost at the same time extend the life of the installed units.

II. THEORETICAL FRAMEWORK

The study is anchored on the the theory of Machine Maintenance and Reliability (Skog, 2006) that describes the need for a machine user to understand and identify the effects and failures of a machine (air conditioner) for managing their impacts and applying the best technical and economical approach to maintenance.

These approaches were then subdivided to different tasks to ensure that the best applicable and cost effective task were selected and that causes of failures were addressed. Upon selecting the approaches, benefits and drawbacks were presented to ensure common understanding on tasks that prevent, monitor, predict and corrects failures on the machine.

In many instances, as an air conditioner user, the awareness on the common maintenance practices of the unit were neglected leading to high cost of electricity bills, shorten the life of the machine and high cost of maintenance.

III. METHODOLOGY

The questionnaire was adapted from the cooling capacity matrix of Matsushita Electric Company that provides easy to understand technical specifications and

multiplying factors for a preset temperature and from the manufacturer's manual provided for each unit installed wherein some modifications were made to suit the need of the study such as the use of the on/off switch, the placement of awning that covers the air conditioner from the direct sunlight.

The first part solicits idea from the respondents who do not possess the technical know - how of air conditioning (non-technical) but have air conditioners at homes or offices. The matching of the cooling capacity was computed based on the cooling capacity matrix from Matsushita Electric Company. Locations or placement of the installed units was taken from the manufacturer's data provided by each unit bought in the market.

The second and third part was taken from the manufacturer's data and solicits awareness level of the respondents on the provision of the installation, care and maintenance units, and the do-it-yourself practices respectively.

The study employs non-probability sampling by quota from samples of office personnel, homeowners (includes lodgers, bed spacers, and transients) residing along the streets of D. Jakosalem, V. Gullas, Sanciango, and Junguera where most of the houses and offices have air conditioners and the occupants were transients. The samples were taken randomly and purposively to have experience cooling comfort provided by air conditioners. Responses were taken during Sundays for a period of one (1) month to ensure there is ample time in answering and give enough space for the respondents to clarify some information printed on the questionnaire. Respondents were marked with numbers and do not have countenance with the researchers in order to remain completely anonymous. From a total of 2042 survey questionnaires distributed, 514 were retrieved (about 25%).

The 514 respondents were then made to respond to the statement "experiencing cooling comfort allows a person to be efficient and productive in a workplace". A validation of strongly agree (5.69 on a 7 point scale) indicates that to experience such comfort continuously, the respondent, in the long run, would buy one unit.

Table 1
Degree of Agreement

<i>Strongly disagree</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>Strongly Agree</i>
				23	11	
	22	55	93	2	2	
$\bar{X} = 5.69$, Strongly Agree						

A chain reaction of buying a unit requires knowledge of the space cooling capacity and location of the unit to maximize result while minimizing cost.

Responses on the information on cooling capacity against space metrics and its location or placement upon installation were analyzed using frequencies, while the

level of awareness on the installation, care and do-it-yourself maintenance of air conditioning units were analyzed using the weighted mean and mean of means with the standard deviation describing the dispersion of the responses from the mean.

IV. RESULTS AND DISCUSSION

The study is divided into two (2) parts. The first is on the information on cooling capacity against space metrics and its location or placement upon installation while the second is on the level of awareness on the installation, care and do-it-yourself maintenance of air conditioning units. Inferentially, people attempt to select an air conditioner while considering the setting or size of a room to install it in, in order to make full use of its capacity (Saito, 2006).

On knowledge of cooling capacity. By asking help from a friend to get the desired cooling capacity got the highest rating from the Homeowners/Lodgers' (195 counts). The concept was the usual way of acquiring the correct air conditioning unit cooling capacity for a space to be cooled; such that a space metrics of 10' x 10', 2-40W lamps and 4 occupants has to be installed by a 1.5 hp air conditioning unit (Matsushita Electric Company Philippines, 2013).

From a store while looking at the unit, got interested was the second option. Homeowners/lodgers (56 counts) who usually have time coming to the mall said that while listening to an appliance attendant when window shopping, got interested. Considerably, the sales agent has knowledge of the unit they are selling that is more on the design structure of the unit, not the space metrics. There is a tendency of buying an air conditioning unit with bigger or smaller cooling capacity than the space being cooled. In both cases, the unit does function at maximum but consumes power just the same, an indication of larger electricity cost.

Whether this action is intentional or inadvertent, this describes the all-too-common situation in which non-technical personnel claimed to be willing to choose and pay more for the product but fail to follow through intentions of what is printed in the product manual (Atkinson, 2013).

It was already installed when we move in was the response of the office personnel (170). Cooling comfort was experienced to be in place upon coming in. This means that the occupant could not identify whether or not the cooling capacity matches with the space metrics.

On Placement of Unit. Different units and rooms of different use have its particular placement of the unit. For consideration: (a) An ordinary room needs an air conditioner placed on the window line upper part to ensure that the conditioned air can circulate the whole space. The homeowners find it a common location (242). Roaming around the suburbs, one can see that most of

the air conditioners are placed on that very location. Such sight infers the idea of standard placement of units on non-technically oriented individuals; (b) For rooms with bedridden occupants, the unit must be placed below window line so that the conditioned air hits directly below the bed. For homeowners (103), this is a common sight for houses with transient occupants. Upon entrance, one can directly feel the coolness of the surroundings; and (c) Other locations include on the floor, ceiling and walls. These are units that come on split-types (that is, the air handling units are inside while the air condensing units are outside). The office personnel (169) find the location very common but not for the homeowners. This location is not ideal for homes because it is intended for larger space with bigger capacity air conditioning units. Unlike the window air conditioners, these units are difficult to remove from the position for cleaning and maintenance thus, needs well-versed maintenance personnel with higher pay.

Accordingly, the first two locations are intended for package – type air conditioners that are limited to 2.5 HP ratings (these units come in one piece – the cool air is dispersed by a blower in front while the hot air is released at the back with a fan). The third location is for bigger cooling capacity units that come in split types system.

The respondents may have varied ideas of where to place the unit that cools the space yet agrees on one thing that is; to stay in cool space is comforting and relaxing.

Level of awareness on the installation, care and do-it-yourself maintenance of air conditioning units. The need to be aware on the use of air conditioners specifically on households is an important aspect in the energy consumption patterns because the life cycle rebound effect of household air-conditioner consumption increases at a mark of 67% (Liu, Sun, Lu, Zhang, & Sun, 2016). The respondents validated the awareness on installation, care and do-it-yourself maintenance on the average (Home owners, 1.88; Office Personnel 1.85). This means that what were heard upon buying the units were the only things remembered by the respondents or what other non-technical person had commented.

Customarily, upon buying the unit, the store attendant would always give its customer a feel for the cooling comfort and what must be done to have the unit produce such cooling comfort. These are found in the booklet that comes with the unit but only those details that were given during the marketing of units were taken into consideration and that other details were left inside or choose to pay the unit but forgets the ethical issue of following the intention of considering the size of a room to install, make full use of its capacity while reducing cost.

On a three (3) point scale, the following details were validated as aware (1.67 to 2.34) and Not Aware (1.00 – 1.66):

- 1) Unit is placed free from obstacles. (Home owners, 1.93; Office Personnel 2.13: **Aware**) Air flow from the unit to the space to be conditioned and back to the unit without blockages. Obstacles are often seen on offices with floor mounted units whereby tables block the return air (louvers with filter at the lower portion of the air conditioner but not with window type).

When the return air is blocked the thermal sensor (thermostat) detects and records the temperature of the air inside the room and if that temperature doesn't match with the desired temperature the motor compressor continues to compress the refrigerant until desired cooling is attained.

Do - it - yourself guide tells the occupants to remove the blockades. This allows the cool air to circulate and allows the thermal sensor to detect the desired temperature and put off the compressor until the temperature rises above the desired one. This is where a homeowner or office personnel help cut cost on electricity bill.

Between a lamp and a motor compressor, one can have great savings on electricity bill if a motor – compressor is not running in just 30 minutes. In a room where there are 4, 40W lamps operating 8 hours at ₱9.40/kW-hr, one pays **₱12.04**. For an air conditioner with a 2.5hp fan motor and 1hp compressor operating 8 hours at the same rate, one pays **₱196.35**. When a lamp (4, 40W) is off for a day is just tantamount to an air conditioner not running for 30 minutes.

- 2) Unit is provided with awning when exposed to direct sunlight. (Home owners, 1.63; Office Personnel 1.40: **Not Aware**) The common practice is that homeowners pay a technician to install the air conditioner and just simply accept the work. After all, what's important to them is that the space is cool. Roof plays an important role in the delivery of cool air and even use as a mitigation technique in urban cities to aid cooling (Santamouris, 2012)
- 3) Main Control Knob is switched to desired position. (Home owners, 2.67; Office Personnel 2.73: **Fully Aware**) Though the respondents are fully aware there is one prevalent condition experience during power failure, the occupants in most cases but not all, forget to turn off the knob.
- 4) Main Control Knob is switched to desired position after 3 minutes the unit had stopped when accidentally “Off” or following a “Power Failure”.(Home owners, 1.57; Office Personnel 1.40: **Not Aware**) Usually the occupants just leave the knob from where it was positioned.

- 5) Unit is “Off” when cleaning the conditioned space. (Home owners, 1.50; Office Personnel 1.47: **Not Aware**) This happens all the time. When the maintenance of the air conditioners is called for, thick layer of dust and other particles stay on the filter and fins of the evaporator and condenser.

- 6) Unit is “On” at least 1 hour before occupants enter the conditioned space. (Home owners, 1.30; Office Personnel 1.40: **Not Aware**) To experience cooling comfort at its best, the space should be cooled before the occupants fully enter the space.

- 7) Unit is “Off” at least 1 hour before occupants leave the conditioned space. (Home owners, 1.27; Office Personnel 1.27: **Not Aware**) To cut down cost on electricity leave the fan On to dispel the cool air that is still circulating the space. Put it Off as you leave the room.

- 8) Vent lever is opened when undesirable odor or smoke need to be expelled from the room (opening on the unit at the bottom that does not allow the air to be recirculated). (Home owners, 2.47; Office Personnel 2.47: **Fully Aware**) This allows the occupants to breathe clean air.

- 9) Air swing is switched “On” to allow wider distribution of cool air (this is the part of the unit having vanes that moves right to left). (Home owners, 2.43; Office Personnel 2.40: **Fully Aware**)

The items indicating the on and off functions are important to the power consumption of the unit. During a power failure, off the unit so that when the power resumes it would not consume an in-rush-current at the same time cools off the compressor and gives it time to go back to a steady state.

Do - it - yourself guide tells the occupants to Turn Off the unit every time low voltage or power failure is experienced. This action lengthens the life of the compressor and cut down maintenance cost. Prevalent practices of the occupants showed that during power failures the unit remains turned on. Theoretically, most units comes with a 5 - year compressor warranty and that the occupants action shorten the life of the compressor adding unwanted cost within the five year period of equipment acquisition.

Also, turning off the unit allows the occupants to cut off electricity bill often referred to as pico - electricity cost. Though not felt on a daily basis but accumulates in a month. Consider a lamp of 0.001W with a life of 3000 hours. Without putting off, it gets busted after 125 days (roughly 4 months) and pays a bill of **₱0.028**.

This holds true to all electronics and electrical consuming devices.

- 10) Horizontal louver is turned upwards for better cool air circulation (this part is located directly above the

knobs or switches). (Home owners, 2.53; Office Personnel 2.53: **Fully Aware**)

- 11) Air filter is removed and cleaned every week (the part of the unit located near the horizontal louver directly placed behind the front cover protecting the evaporator from accumulating dust). (Home owners, 1.33; Office Personnel 1.20 : **Not Aware**). Filtering is the ability of the air cleaner of the unit to remove contaminants or suspended particles in the fresh charge as it is drawn into the air conditioner under specified test conditions (Toma & Bobalca, 2016).

The filter screen collects the dust and other particles from cigarettes, allergen-producing pets and other pollutants that go with air from the surroundings and can be a source of bacteria that has to be cleaned regularly (Wallace, 2008). These are trapped by the screen and prevented from entering the evaporator screen. If not cleaned then, this would stay in the cooling fins of the evaporator. When the filter of the unit accumulates dust and other particles, it would form icicles and hinders the thermostat from sensing the right temperature of the evaporator coils. This action multiplies the consumption of electricity since the motor – compressor continuously compresses the refrigerant until the desired coolness is attained. Replacement or cleaning the filter must always be considered (Toma & Bobalca, 2016).

Do - it - yourself guide tells the occupants to Turn Off the unit when cleaning the space and wash - clean the filters and louvers every week. Dust and other particulates stay on the louvers and filters before it reaches the fins of the evaporators and when not cleaned forms icicles that hinders the thermostat from sensing the desired temperature. For an ordinary homeowner, it does not just simply cut down electricity bills but also include the maintenance cost of cleaning the unit. To further save power bills, one has to cool the space before the occupants came in and have the coolness stay. Before leaving, have an hour to feel the coolness with just the fan circulating.

To work and live comfortably and efficiently in the Philippines that is hot and humid, one needs to have an air conditioner that maintains the coolness of the room within 22°C - 25°C. To experience such comfort, one has to pay the price that need not be expensive. This is achieved by being aware of the best practices before and after acquiring an air conditioner at homes and offices as a means of austerity measures. These practices includes matching the cooling capacity of the unit through the use of the matrix calculation from a known source; placement of the unit as specified by the

service manual provided upon buying the unit and not just from what had been seen anywhere; and read through the servicing and maintenance manual (do-it-yourself) provided once the unit is installed.

Do-it-yourself care and maintenance focuses on condition of cost saving that is reducing the bill. A simple homeowner need to practice turning on/off the unit one (1) hour before and after use, when cleaning the area and when experiencing low voltage or power failure; clean the filter and louvers every week and replace filters when worn out. It can be construed that people at homes and in offices wanted to stay in a cool environment provided by airconditioners. Matched to such want is the enhanced knowledge of the cooling capacity, location of placement and the day to day servicing of the unit to continually provide cooling comfort while prolonging the unit's life and saving costs.

Such knowledge can be gained through reading the manual provided, otherwise pay the corresponding cost from a professional.

V. CONCLUSION

It can be construed that people at homes and in offices wanted to stay in a cool environment provided by airconditioners. Matched to such want is the enhanced knowledge of the cooling capacity, location of placement and the day to day servicing of the unit to continually provide cooling comfort while prolonging the unit's life and saving costs.

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